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The characterization of socio-political instability, development and sustainability with Fisher information

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ABSTRACT

In an effort to evaluate socio-political instability, we studied the relationship between dynamic order, socio-political upheavals and sustainability in nation states. Estimating the degree of dynamic order inherent in the socio-political regime of various countries throughout the world involved applying Fisher information theory to data from the Political Instability Task Force database. Fisher information is a key method in information theory and affords the ability to characterize the structure and dynamics of complex systems. The results of this work demonstrate that nation states bifurcate into two distinct regimes, which exhibit a negative correlation between dynamic order, as determined by Fisher information, and the prevalence of upheavals. Countries in the High Incidence of Upheavals regime with low dynamic order (i.e., low Fisher information) experienced sixteen times more upheavals than the countries in the Low Incidence of Upheavals regime with high dynamic order (i.e. high Fisher information). Most importantly, our analysis demonstrates that newly industrializing countries suffer from the most instability, which is manifested in low dynamic order thereby resulting in a high number of upheavals. These results suggest that developing countries endure a period of socio-political instability on their path to the developed world.

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1. Introduction

The awareness of the strong links between socio-political and ecological systems has increased over time (Lubchenco, 1998). Environmental degradation is often a key contributor to socio-political instability, and democracy-building is not likely in the face of poor stewardship of the environment (Lubchenco, 1998). Further, understanding long-term trends in socio-political development can help in catalyzing a transition to sustainability (Kates and Parris, 2003).

Countries with sustainable economies will exhibit less instability over time than countries with unsustainable economies (Goodland, 1995). This is likely so, because countries that are quickly using their own resources will need to “capture” more resources from other countries. If an unsustainable economy cannot secure additional resources via the market, that country may resort to securing additional resources via force. This presents a problem from the environmental perspective, because good governance and socio-political stability are precursors to environmental protection and sustainability (Rees, 2006). These are unlikely in the presence of upheavals that result in human deaths and suffering, destroy infrastructure, and divert attention and resources away from environmental stewardship and sustainability (Kates and Parris, 2003). Since socio-political and ecological systems are linked (Kates et al., 2001), a global transition to sustainability is dependent upon maintaining socio-political order in the face of change (Kates and Parris, 2003). Lubchenco (1998) speculated that the future trajectory of earth would likely be characterized by rapid change, and greater uncertainty about the dynamics of ecological, as well as social and political systems.

In this study, we explored the relationship between dynamic order, socio-political upheavals and sustainability in nation states. We applied Fisher information (FI) theory to data from the Political Instability Task Force (PITF) database (http://globalpolicy.gmu.edu/pitf/pitfdata.htm) to estimate the degree of dynamic order inherent in the socio-political regime of various countries throughout the world. We also explored the relationship between dynamic order and sustainability by analyzing data from the Environmental Sustainability Index (ESI).

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2. Methods

2.1. Fisher information

FI was developed by the statistician Fisher (1922) as a measure of the amount of information in data. It is a key method in Information Theory and provides a means of monitoring system variables in order to assess the dynamic order of a system (Cabezas et al., 2003). The form of FI used in this work was derived by Fath et al. (2003) and Mayer et al. (2007) as:

$$I = \int \frac{1}{p(s)}\left[\frac{\mathrm{d}\,p(s)}{\mathrm{d}s}\right]^2 \mathrm{d}s \quad (1)$$

where, $p(s)$ is the likelihood of observing a particular state (s) of the system.

While Eq. (1) may be evaluated analytically or numerically (Mayer et al., 2007; Karunanithi et al., 2008), the numerical approach affords the ability to assess both real and model systems and is derived as follows. Picking up from Eq. (1), we minimize calculation errors that may result from very small $p(s)$ by replacing the probability density with its amplitude, i.e. $q^2(s) \equiv p(s)$. Next, dp/ds is solved as a function of q, such that:

$$\frac{\mathrm{d}\,p}{\mathrm{d}s} = 2q\frac{\mathrm{d}q}{\mathrm{d}s} \therefore \left(\frac{\mathrm{d}\,p}{\mathrm{d}s}\right)^2 = 4q^2\left(\frac{\mathrm{d}q}{\mathrm{d}s}\right)^2 \quad (2a)$$

Eq. (2a) is substituted into Eq. (1):

$$I \to \int \frac{\mathrm{d}s}{q^2} 4q^2\left(\frac{\mathrm{d}q}{\mathrm{d}s}\right)^2 \to 4\int \left[\frac{\mathrm{d}q}{\mathrm{d}s}\right]^2 \mathrm{d}s \quad (2b)$$

For use with discrete data, the integral is approximated by a summation and simplified resulting in:

$$I = 4\sum_{i=1}^{n}[q_i - q_{i+1}]^2 \quad (3)$$

Further details of the analytical and numerical derivation of Fisher information can be found in Mayer et al. (2007) and Karunanithi et al. (2008), respectively.

The basis of computing FI is evaluating the state (i.e. condition) of the system. As such, we use n measurable variables (x_i) to characterize a system over time resulting in a trajectory in a phase space of n dimensions and time (Mayer et al., 2007). Each point pt_i in this trajectory is defined by specific values for each variable, i.e. pt_i: $[(x_1(t_i), x_2(t_i), x_3(t_i), \ldots, x_n(t_i)]$ at a specific time. Given that there is uncertainty in any measured value, each state s of the system is a region bounded by a level of uncertainty (Δx_i), such that if $|x_i(t_i) - x_i(t_j)| \le \Delta x_i$ is true for all variables, then the two points are indistinguishable and noted as being in the same state of the system (i.e. binned together). Accordingly, the probability $p(s)$ of a system being in a particular state (s) can be estimated by counting the number of points defined inside a particular state. This approach affords the ability to designate all possible states of the system over time.

One of the key elements of this approach is handling the uncertainty inherent in real data. Since the measurement uncertainty is typically unknown, two mechanisms have been devised to manage it: setting a size of the states and using tightening levels when computing FI. The size of states (i.e. Δx_i) may be estimated by computing the standard deviation for each variable within a stable (minimal variation) time period in the system trajectory (Karunanithi et al., 2008), and then applying Chebyshev's theorem which indicates that independent of the type or form of the probability density function, the likelihood of observations falling within k standard deviations of the mean is at least $1 - 1/k^2$ (Lapin, 1975). Another approach is to locate a surrogate system characterized by the same variables that exhibits stability and assume that the variation within this system is an estimated measure of uncertainty for the system under study. Tightening levels are implemented to loosen the size of states criteria such that a point can be declared within a particular state of the system if some percentage of the variables fits within the boundary of uncertainty (Δx_i). For example, a particular system may be characterized by 100 variables, and if 95 of the variables indicate that a point fits within the boundary of uncertainty (i.e. satisfy the size of states criteria), then the point would be binned in that state at the 95% tightening level.

Since FI is based on the probability of observing different states of the system over time, the variable time series are processed in moving time windows. Then PDFs are generated and FI is computed for each time window. The general methodology employed to compute FI is as follows: (1) establish the size of the time windows (hwin), (2) determine the time increment the window will move forward (winspace) to create overlapping windows, (3) set a tightening level, (4) bin all of the points into states within each time window, (5) compute the probability density for each state in each time window, (6) calculate FI from the PDF in each time window, (7) set a new tightening level, (8) repeat Steps 4 through 7 until all the required tightening levels have been used and (9) compute mean FI over time. Further details of the methodology are provided in Karunanithi et al. (2008).

According to Eq. (1), FI is proportional to the change in probability over the change in state (i.e. dp/ds). Since information may only be obtained when patterns are observable in the data (i.e., completely random data has no pattern and zero Fisher information), it is clear that the very presence of patterns implies the existence of order. In this context, systems exist between two idealized extremes, perfect disorder and perfect order. The perfect disorder case occurs when a system is unbiased toward any particular state. Accordingly, the system lacks order and has an equal probability of being in any state of the system resulting in a uniform PDF and FI approaching zero (Fath et al., 2003). Perfect order occurs when repeated measurements of the system result in the same state over time. This more structured system has high order and is biased toward a particular state or states. Accordingly, the PDF has a steep slope and FI approaches infinity (Fig. 1). However, real systems typically exist between these two extremes (Fig. 1).

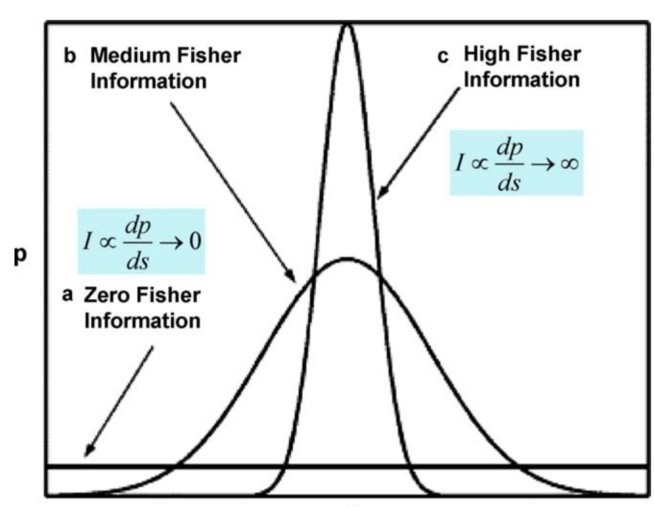

Fig. 1. Fisher information is proportional to the likelihood of observing the system in a particular state (Pawlowski and Cabezas, 2008). (a) A system that has an equal probability of being in any state is chaotic and disordered; accordingly, $I \to 0$. (b) However, when a system is biased toward a state (or finite number of states), it is more orderly and $I \to \infty$. (c) Most systems exist between these two extremes.

2.2. Approach

To quantify FI for various countries, we selected key state variables from the Phase 3 data compiled by the Political Instability Task Force (PITF) (Goldstone et al., 2000) which assesses political instability and state failure. For this study, we used data from 1960 to 1997 for the countries in which there were complete time series characterizing the demographic, social, political, leadership, economic and environmental aspects of each country (see Table A.1). As such, the data set includes 67 countries each characterized by 21 variables over 37 years. The upheaval data was not used for calculating the values of FI, but was used for the FI analysis. The size of the state (i.e. level of uncertainty) for the study was calculated using Sweden (i.e. a surrogate system) as it had not suffered from any major socio-political upheavals during the study period. Accordingly, we assumed that any variation in the time series data was natural, random variation, and computed the standard deviation (σ) of the Sweden data for each of the 21 variables. This was used to set the level of uncertainty (Δx_i) for the study to $\pm 2\sigma$ of the Sweden data. FI was computed for each time window and is reported as a mean FI for each country.

Once the mean FI was computed, we compared it to the mean number of upheavals by country and then aggregated the results by level of development and type of government. We also explored sustainability using the Environmental Sustainability Index (ESI) and compared it with FI. The ESI characterizes the environmental stewardship of a nation and is represented by a score from 0 (most unsustainable) to 100 (most sustainable). This composite metric, based on a weighted average of 21 indicators, covers 5 pertinent components of environmental sustainability to include environmental systems, reducing environmental stresses, reducing human vulnerability to environmental stresses, societal and institutional capacity to respond to environmental challenges and global stewardship. In conjunction with the Environmental Performance Measurement Project, the 2005 report contains ESI data for 146 nations (Esty et al., 2005).

The upheaval data was also gathered from the Phase 3 PITF dataset. The PITF methodology for estimating upheavals assigns the cumulative number of upheavals for the previous 15 years to a given year. The time series data for the cumulative number of upheavals over the previous 15 years from the PITF database was averaged over the period of study to obtain ACNU15 values for the countries. Please refer to Table A.2 for the list of countries, their mean FI, mean upheavals, ESI, type of government and level of development.

3. Results

Fig. 2 demonstrates a bimodal and strong negative correlation between FI and the average number of upheavals for a large cross-section of countries. This relationship converges asymptotically to zero at higher FI values. As noted in the figure, at FI ~3.7, there is a transition in behaviour. The countries bifurcate into two distinct regimes, a High Incidence of Upheavals (HIU) regime and a Low Incidence of Upheavals (LIU) regime. The mean FI is 2.56 and 5.08 for countries in the HIU regime and the LIU regime, respectively. The HIU regime has on average 7.35 upheavals, while the LIU regime has only 0.46. When we aggregated the mean FI and the mean number of upheavals (see Fig. 3), we observed a strong negative correlation ($\rho = -0.93$). Moreover, we studied these parameters as a function of development (Table 1 and Fig. 4) and note that they have a strong negative correlation ($\rho = -0.96$). Further, we find that while developed countries (e.g. Sweden, Norway, etc.) have the least upheavals and highest FI, the converse is true of newly industrialized countries (e.g. China, Philippines, etc.). Finally, as shown in Table 2, we grouped the data by type of government and assessed the relationship between mean FI, upheavals and the ESI. When aggregated in this way, both the number of upheavals and ESI are strongly correlated with FI, with correlation coefficients of $\rho = -0.67$ (Fig. 5a) and $\rho = 0.70$, respectively. Further, as shown in Fig. 5b, ESI and mean upheavals are negatively correlated ($\rho = -0.48$). The communist form of government (e.g. China) has the lowest FI and most of the

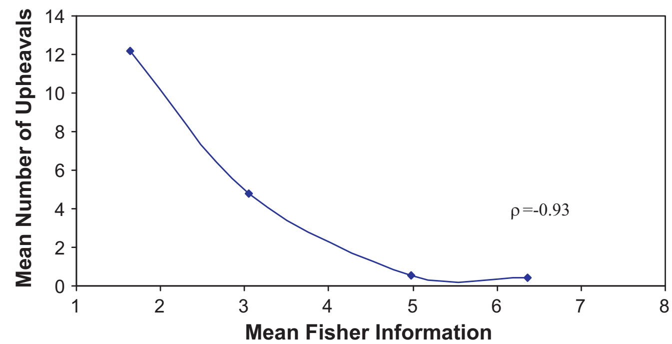

Fig. 3. Mean number of upheavals vs. mean FI.

Table 1
Mean FI and upheavals (by development).

Development	Mean	
	FI	Upheavals
Newly industrialized countries	1.90	10.28
Other developing countries	3.04	5.24
Least developed countries	3.63	5.82
Developed countries	4.70	1.20

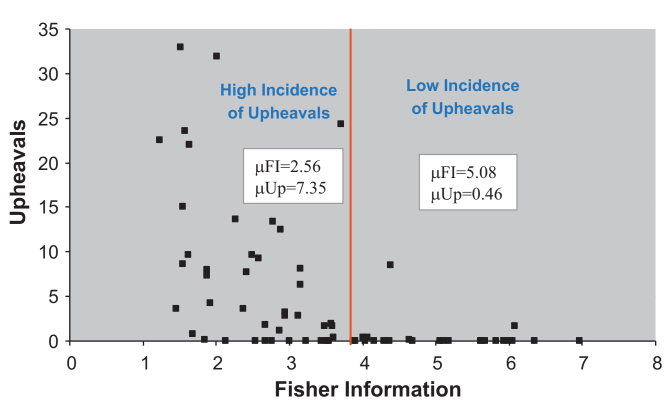

Fig. 2. Mean FI vs. mean upheavals (by country).

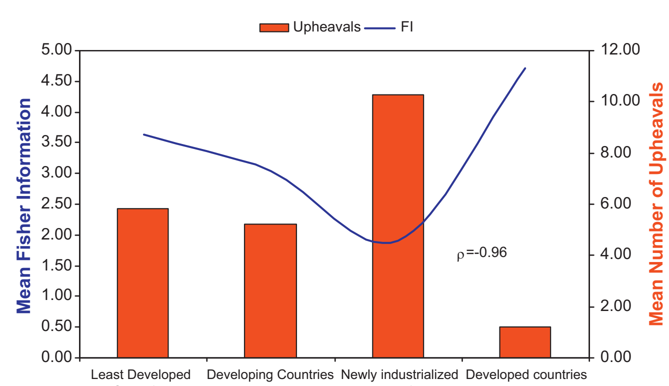

Fig. 4. Mean FI vs. mean number of upheavals (by development)

Table 2
Mean FI, upheavals and ESI (by type of government).

Key	
Min	Max

Government	Mean FI	Mean Upheavals	ESI
Communist	1.23	22.57	38.60
Constitutional democratic republic	2.01	31.86	44.00
Constitutional monarchy	4.30	3.56	57.30
Constitutional monarchy and commonwealth realm	4.39	8.43	50.20
Constitutional republic	3.83	3.42	63.97
Democratic constitutional republic	3.44	0.00	47.40
Democratic republic	3.72	4.05	51.65
Federal parlimentary democracy and commonwealth realm	4.69	0.00	61.00
Federal republic	2.97	3.41	53.36
Military junta	2.71	16.47	47.70
Monarchy	2.67	0.00	37.80
Parlimentary democracy	2.27	13.62	50.90
Parlimentary democracy and commonwealth realm	5.93	0.00	61.00
Parlimentary democracy, federation and commonwealth realm	3.54	0.00	64.40
Parlimentary gov't w/ constitutional monarchy	4.16	0.00	57.30
Parlimentary monarchy	3.00	0.00	48.80
Parlimentary republic	4.04	0.41	47.90
Republic	3.29	4.78	50.97
Republic parlimentary democracy	3.95	2.45	53.33

parliamentary forms of government (e.g. New Zealand, Canada, Japan, Spain, and Burkina Faso) have low number of upheavals. The parliamentary democracy, federation and commonwealth realm (e.g. Canada) has the highest ESI value. Moreover, while the parliamentary democracy commonwealth (New Zealand) is characterized by the highest FI, lowest upheavals and high ESI, the communist government has the lowest FI, relatively high upheavals and low ESI.

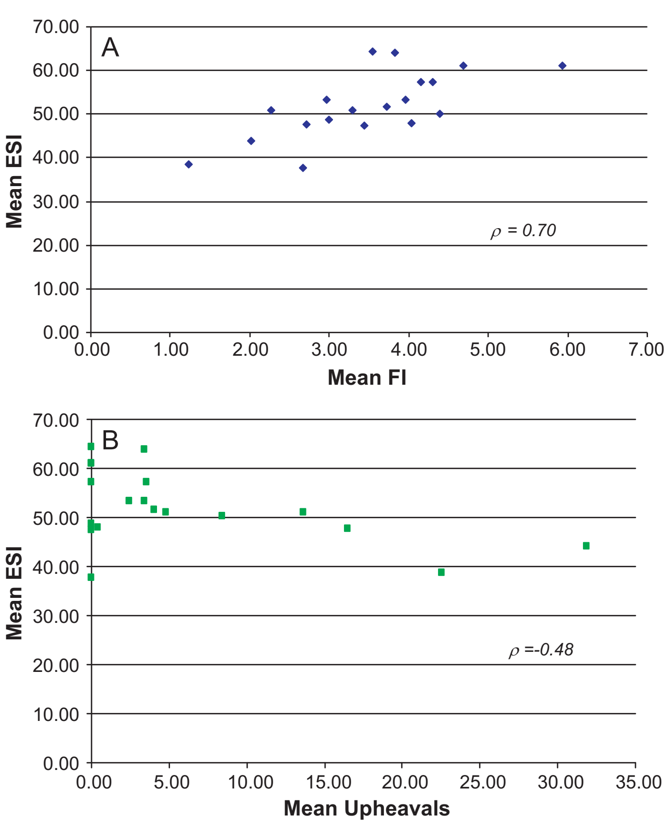

Fig. 5. Mean FI, ESI, and upheavals by type of government. When aggregated by the type of government, ESI (A) exhibits a strong positive correlation with FI and (B) is negatively correlated with the number of upheavals.

4. Discussion

Social organizations such as countries exist in a continuous process of change punctuated by relatively stable regimes (Wiek et al., 2006). The development trajectory of countries from least developed to fully developed can be viewed as such a process. Countries evolving from least developed to developed naturally undergo profound changes that may include transformations in their social structure, economies, and form of government. These changes in organization can be manifested as changes in dynamic order which can be quantified as changes in FI.

FI provides a method for assessing the socio-political dynamics of nation-states, and allows for an assessment of the likelihood of a particular nation to suffer from socio-political upheavals. This method is a powerful tool for assessing the regime in which a particular nation resides. Our results show that countries bifurcate into two distinct regimes with, respectively, low FI and many upheavals and high FI and few upheavals. There is a negative relationship between FI and upheavals in the HIU regime which converges into an asymptotic relationship tending to zero in the LIU regime. The ability of FI to capture a robust, consistent and strong relationship with upheavals in a highly complex non-physical system is a significant result. The results show that the countries in the HIU regime are characterized by an average of 16 more upheavals and half the FI of the LIU regime denoting a significant change in the level of socio-political stability. The results also demonstrate that newly industrializing countries experienced the most socio-political upheavals, which is strongly correlated with loss of dynamic order.

We also explored whether socio-political upheavals and FI are related to the development level of the countries in the analysis (Table 1 and Fig. 4). Countries in the dataset were classified as developed and developing (CIA World Factbook, 2007) and where appropriate, the developing countries were further classified into least developed (UN Conference on Trade and Development 2006) and newly industrializing countries (Bożyk, 2006; Mankiw, 2007). In this study newly industrializing countries are those which are experiencing rapid growth outpacing their developing counterparts. Fig. 4 shows the average FI of the sixty-seven countries grouped according to their development level. The transition from least developed to newly industrialized country incurs a major drop in FI (3.6–1.9) and a significant increase in the average number of upheavals (5.8–10.3). The least developed countries are characterized by well established patterns with low variability leading to high dynamic order (i.e., high FI). The pattern associated with developing and newly industrializing countries are those of a transition regime or a stage in development, characterized by extremely high activity and a resultant low dynamic order (i.e. low FI). The transition from newly industrializing country to a developed country brings a major increase in FI (1.9–4.7) and a significant drop in the number of upheavals (10.3–1.2). This suggests that nations that industrialize undergo a systemic transition (characterized by disorder), and a reorganization, in the process of becoming members of the developed world.

In addition, we assessed the relationship between FI, upheavals and ESI by governmental type. An aggregation of the data at this level underscores the correlation between environmental sustainability (i.e. ESI) and both dynamic order (i.e. FI; $\rho = 0.70$) and the number of upheavals ($\rho = -0.48$) (Fig. 5A and B). Further, in Table 2, we are able to highlight the stability of the parliamentary forms of government (e.g. New Zealand) which are typically characterized by relatively high FI and ESI, and low upheavals. The opposite result is true for communist (e.g. China) and constitutional democratic republic forms of government (e.g. Guatemala).

Armed conflict has direct, negative impacts on the environment (for an extensive treatment see Conca and Wallace, 2009). In particular, social upheaval has: (1) direct effects on ecological systems (i.e., resource depletion, poor environmental management); (2) indirect effects via disruption of critical institutions and infrastructure; and (3) indirect effects caused by refugees making unsustainable choices due to starvation, need for shelter, etc. (Conca and Wallace, 2009). Demographic change can also have a negative impact on the sustainability of a resource base, which in turn can disrupt socio-political stability (Adger et al., 2002). Adger et al. (2002) document that demographic change in Vietnam brought about the loss of forest cover, intensification of agriculture and depletion of renewable resources, via migration that resulted in changes in consumption and production patterns. Thus, demographic change indicates social upheaval (e.g., conflict, economic change) that can have a negative effect on the resilience of social-ecological systems (Adger et al., 2002). Further, as social-ecological resilience erodes, the sustainability of a system declines (i.e., environmental degradation) (Adger et al., 2002).

Fredriksson and Svensson (2003) found that corruption reduces the effectiveness of environmental regulations, but the impact of corruption lessens as political instability increases. On its face, it would appear that high corruption and political instability would have a compounding negative effect on environmental regulations, but, at least in this study, this is not the case (Fredriksson and Svensson, 2003). This result highlights that the connections between socio-political instability, development and sustainability are not "cut and dried"; much more research is warranted in this area. Pellegrini and Gerlagh (2006) contend that it is less likely that environmental quality can be improved in developing countries (i.e., increasing economic growth) with dysfunctional institutions, but they argue that by improving institutions and reducing corruption, developing countries can induce higher economic growth rates and better environmental policies (Pellegrini and Gerlagh, 2006).

Socio-political instability and institutional failure has been shown to result in insecure property rights, which in turn resulted in unsustainable rates of deforestation in many countries (Deacon, 1994; see also Bhattarai and Hammig, 2001). In a recent study of Latin American countries, Culas (2007) found that by improving institutions countries could reduce their rates of deforestation while also enjoying economic growth. Improved institutions allowed for this shift via enhanced property rights and better environmental policies (Culas, 2007). Didia (1997) found a negative correlation between the level of democracy (i.e., country becomes more "democratic") and the rate of deforestation in a study of developing nations. In particular, environmental groups, market mechanisms, free elections and a free press are highlighted as aspects of democracies that make them more stable, with better institutions, and a greater capacity for good environmental stewardship (Didia, 1997).

Conca and Wallace (2009), citing a significant body of literature, build a case indicating that poor environmental stewardship precludes socio-political stability. They contend that poor environmental stewardship will result in increased vulnerability to natural disasters, as well as a strong negative impact on the institutions necessary for socio-political stability (Conca and Wallace, 2009). In particular, they argue that the quality of environmental stewardship is at the threshold of whether a developing country travels down a peaceful or violent path. These examples make clear that exploring the interaction between environment, development and socio-political instability is important on a global scale.

With respect to the observed systemic transition from the developing to the developed regime, the implication is that service economies create less pollution than countries with large industrial bases (Jahn, 1998). Thus, the degree of modernization and economic wealth is associated with countries that have made the shift to the developed world (Jahn, 1998). As economies develop, they should be expected to pass through stages of development, where certain aspects of environmental quality (e.g., air quality) initially deteriorate and then improve with time (Selden and Song, 1994; Grossman and Krueger, 1995). Environmental issues have a substantial effect upon economic transitions (Chimeli, 2003). Studying transition economies in the former Soviet bloc, Chimeli (2003) found that environmental quality was effected by the existence of and strength of relevant institutions. Creating and/or strengthening these institutions is very difficult when the country of interest suffers from a weak economy (Chimeli, 2003). One recent study found that environmental quality is better when there is more political competition coupled with a high number of environmental groups; in short, environmental quality is dominated by socio-political factors (Grafton and Knowles, 2004). Further, the likelihood of having sufficient environmental quality depends on the stage of economic development (Xepapadeas and Amri, 1998). As economies grow in developing countries, pollutants decline at a faster rate than in low-income countries (Xepapadeas and Amri, 1998). The degree of democracy has also been shown to have a positive effect on environmental quality (Bernauer and Koubi, 2005).

Barrett and Graddy (2000), in a study analyzing numerous pollution variables, found that environmental quality improves with advances in civil and political freedoms. Congleton (1992) found that the political regime is an influential factor in determining the environmental policy of a country. In particular, the recent increase in democratic regimes implies that there will be greater support for global environmental agreements in the future (Congleton, 1992). Along this line, Jahn (1998) found that institutional factors are important for a shift to sustainability, however, the degree of mobilization of environmental entities is the primary driver in such a shift. Richer countries typically have stricter environmental standards and enforcement than middle-income and poorer countries, which indicates that environmental quality is linked to socio-political development (Grossman and Krueger, 1995). Thus, a transition to sustainability requires economic (Arrow et al., 1995) and political reforms (Barrett and Graddy, 2000), which are most likely to occur in stable nation-states.

5. Conclusions

So does socio-political stability precede good environmental stewardship or vice versa? It is a difficult question due to the multi-causal interactions between instability and sustainability in complex systems. What we do know is that monitoring, which is critical to sound environmental management, is unlikely or severely reduced in periods of social upheaval (Conca and Wallace, 2009). There are a number of examples that illuminate the dynamic interactions between environment, development and socio-political instability, and other factors. For instance, in Liberia, social upheaval disrupted the rearing of cattle, which led to the illegal harvest and trade of wildlife for local consumption and export (Conca and Wallace, 2009). Liberia faced many challenges to good environmental stewardship (e.g., ineffective institutions, lack of funds), which were either created by or inflamed by social upheaval (Conca and Wallace, 2009). As Conca and Wallace (2009) contend, the Liberian example makes clear that there are spillover effects in nations undergoing systemic transitions.

How do we reconcile the interaction between socio-political instability, development and sustainability? Fraser et al. (2003) offer the Rwandan genocide as an example of the difficulty associated with determining the cause of social and environmental instability. They cite multiple authors, some of whom focused upon the social and political development of Rwanda as the root cause of the turmoil, while other commentators asserted that the genocide was driven by environmental degradation (Fraser et al., 2003). It is most likely that in these complex systems, there is no single "cause" of instability or an unsustainable state. Rather, the interaction between social and environmental factors creates the requisite conditions that result in system instability, a condition Fraser et al. (2003) characterize as a reflexive relationship between human society and the environment. Culas (2007) argues that sound institutions and the rule of law will result in a process where there will be less pressure on natural resources, which is critical to a transition to sustainability. Our results suggest that FI is a useful tool for understanding these dynamic interactions between socio-political and environmental systems.

Appendix A

See Tables A.1 and A.2.

Table A.1
Variable list and description.

DESCRIPTION	ABBREVIATION
Problem Country Indicator	SFTPCONS
Population Density (Ppl/Sq.Km)	WDIPOPD
Total Population	WDIPOPT
Trade(% GDP)	WDIOPEN
Population- Largest Ethnic Group	CULETHP1
Population- Largest Religious Group	CULRELP1
Real GDP Per Capita (chain index)	PWTRGDPC
Infant Mortality Rate	UND26Y
Democracy Index	POLDEMOC
Autocracy Index	POLAUTOC
Discrimination Score	DISPOTA2
Years Leader Was In Office	BNNYROFF
Cropland Area	FAOLAREA
Forest/Woodland Area	FAOWOODS
% Population In Urban Areas	UNUURBPC
No. Of Border States States With Civil/Ethnic Conflict	MACNCIV
No. Of Border States With Any Type Of Major Conflict	MACNAC
Memeberships In Regionally Defined Organizations	CIOD
Maximum Yearly Magnitude Score	SFTPMMAX
Religion Homogenity Index	CULHREL
Ethnic Homogenity Index	CULHETH

Category	#
Policital and Leadership	7
Demographic and Social	10
Economic and Environmental	4

Table A.2
Data aggregation.

Country	Continent	Government	Development	Mean FI	Mean Upheavals	ESI
China	Asia	Communist	Newly Industrialized	1.23	22.57	38.60
Guatemala	Latin America	Constitutional democratic republic	Developing	2.01	31.86	44.00
Morocco	Africa	Constitutional monarchy	Developing	1.61	9.62	44.80
Ghana	Africa	Constitutional monarchy	Developing	3.13	2.84	52.80
Malaysia	Asia	Constitutional monarchy	Newly Industrialized	2.89	12.46	54.00
Thailand	Asia	Constitutional monarchy	Newly Industrialized	1.46	3.59	49.80
Denmark	Europe	Constitutional monarchy	Developed	6.34	0.00	58.20
Norway	Europe	Constitutional monarchy	Developed	6.04	0.00	73.40
Sweden	Europe	Constitutional monarchy	Developed	6.97	0.00	71.70
Netherlands	Europe	Constitutional monarchy	Developed	5.99	0.00	53.70
United Kingdom	Europe	Constitutional monarchy and commonwealth realm	Developed	4.39	8.43	50.20
Paraguay	Latin America	Constitutional republic	Developing	3.87	0.00	59.70
Peru	Latin America	Constitutional republic	Developing	1.54	8.65	60.40
Uruguay	Latin America	Constitutional republic	Developing	6.09	1.62	71.80
Honduras	Latin America	Democratic constitutional republic	Developing	3.44	0.00	47.40
Dominican Rep.	Latin America	Democratic republic	Developing	3.16	8.11	43.70
Costa Rica	Latin America	Democratic republic	Developing	4.29	0.00	59.60
Australia	Oceania	Federal parliamentary democracy and commonwealth realm	Developed	4.69	0.00	61.00
Nigeria	Africa	Federal republic	Developing	1.87	7.95	45.40
India	Asia	Federal republic	Newly Industrialized	1.54	15.03	45.20
Austria	Europe	Federal republic	Developed	5.67	0.00	62.70

Table A.2 (*Continued*)

Country	Continent	Government	Development	Mean FI	Mean Upheavals	ESI
Switzerland	Europe	Federal republic	Developed	5.63	0.00	63.70
Mexico	Latin America	Federal republic	Newly Industrialized	1.84	0.08	46.20
Brazil	Latin America	Federal republic	Newly Industrialized	1.69	0.81	62.20
Venezuela	Latin America	Federal republic	Developing	2.54	0.00	48.10
Mauritania	Africa	Military junta	Least Developed	3.90	0.00	42.60
Myanmar/Burma	Asia	Military junta	Least Developed	1.51	32.95	52.80
Saudi Arabia	Asia	Monarchy	Developing	2.67	0.00	37.80
Israel	Asia	Parliamentary democracy	Developed	2.27	13.62	50.90
New Zealand	Oceania	Parliamentary democracy and commonwealth realm	Developed	5.93	0.00	61.00
Canada	Northern America	Parliamentary democracy, federation and commonwealth realm	Developed	3.54	0.00	64.40
Japan	Asia	Parliamentary gov't w/ constitutional monarchy	Developed	4.16	0.00	57.30
Spain	Europe	Parliamentary monarchy	Developed	3.00	0.00	48.80
Burkina Faso	Africa	Parliamentary republic	Least Developed	4.07	0.41	45.70
Greece	Europe	Parliamentary republic	Developed	4.00	0.41	50.10
Madagascar	Africa	Republic	Least Developed	3.59	1.62	50.20
Cameroon	Africa	Republic	Developing	3.51	0.00	52.50
Central Afr. Rep.	Africa	Republic	Least Developed	5.10	0.00	58.70
Chad	Africa	Republic	Least Developed	3.70	24.27	45.00
Congo	Africa	Republic	Developing	3.60	0.41	53.80
Gabon	Africa	Republic	Developing	5.19	0.00	61.70
Egypt	Africa	Republic	Developing	2.37	3.62	44.00
Tunisia	Africa	Republic	Developing	3.57	1.95	51.80
South Africa	Africa	Republic	Newly Industrialized	2.41	7.76	46.20
Benin	Africa	Republic	Least Developed	2.94	2.84	47.50
Côte d'Ivoire	Africa	Republic	Developing	3.53	0.00	47.30
Niger	Africa	Republic	Least Developed	2.76	0.03	45.00
Senegal	Africa	Republic	Least Developed	2.67	1.78	51.10
Togo	Africa	Republic	Least Developed	5.06	0.00	44.50
South Korea	Asia	Republic	Developed	3.49	1.62	43.00
Sri Lanka	Asia	Republic	Developing	3.16	6.30	48.50
Indonesia	Asia	Republic	Developing	1.63	21.96	48.80
Philippines	Asia	Republic	Newly Industrialized	1.57	23.55	42.30
Finland	Europe	Republic	Developed	5.83	0.00	75.10
Italy	Europe	Republic	Developed	4.04	0.00	50.10
France	Europe	Republic	Developed	2.13	0.00	55.20
Haiti	Latin America	Republic	Least Developed	4.64	0.16	34.80
El Salvador	Latin America	Republic	Developing	2.77	13.38	43.80
Nicaragua	Latin America	Republic	Developing	2.59	9.22	50.20
Argentina	Latin America	Republic	Newly Industrialized	2.49	9.59	62.70
Bolivia	Latin America	Republic	Developing	3.23	0.00	59.50
Chile	Latin America	Republic	Developing	2.94	3.24	53.60
Colombia	Latin America	Republic	Developing	1.93	4.24	58.90
Ecuador	Latin America	Republic	Developing	2.87	1.22	52.40
Turkey	Asia	Republic parliamentary democracy	Newly Industrialized	1.87	7.35	46.60
Ireland	Europe	Republic parliamentary democracy	Developed	5.61	0.00	59.20
Portugal	Europe	Republic; parliamentary democracy	Developed	4.37	0.00	54.20

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